the mass of the same particle for slow speed; calculation makes it 3·1 times. When the speed is $2{\cdot}59 \times 10^{10}$, the observed mass ratio is 2·04; calculation makes it 2·0. When the speed is $2{\cdot}36 \times 10^{10}$, observation gives the ratio 1·65, calculation 1·5, which is not quite so good an agreement; but even this is nearer than anyone could have anticipated, while the other results are extraordinarily close. If Kaufmann's results stand the test of criticism and repetition, they constitute a verification of a fact which is of the utmost importance and of the highest theoretical interest, for it has the effect of reducing the whole Matter in the universe to Electricity, not as a speculation, but as an established truth. It would be rash to jump to such an important conclusion too hastily; and there remains a great outstanding difficulty, hardly yet even faced, concerning the nature of positive electricity—that vague and cometary termination of lines which at the other end are intensely concentrated.

Moreover, the view taken by J. J. Thomson of the nature of the lines of force—whereby their momentum when moving depends upon the mass of ether vortically included in each and inseparable from it—cannot be said exactly to *explain* "mass." Material mass is first explained electrically, and then electrical mass is relegated to the inertia of ether,—not the great bulk of ether, which may be as regards locomotion immovable, but the core of the columnar vortices associated with and essentially constituting the particles of which atoms of matter are composed. The massiveness of ether itself would thus be an unexplained fundamental fact, and its density would have to be regarded as extremely great. The probably high density of ether had already been surmised by FitzGerald and others, and although by this means the cosmos is reduced to a kind of glorified hydrodynamics, yet the fundamental properties of the continuous fluid itself remain unexplained and to all appearance inexplicable.

This may be regarded as a defect, but, after all, explanation always proceeds by stages, reducing the complex to the simple and introducing unification; it can hardly be considered likely that any theory accessible to us here and now can give anything approaching an *ultimate* explanation even of the simplest thing. If the present theory can be substantiated, with whatever modifications and enlargements may be found to be necessary, it will be an immense step in advance; but it would be premature to suppose that these views are in any sense final, or that they will be promptly and universally accepted. They have been led up to by the progress of science during the last quarter century, and a welcome has been gradually prepared for some of them, but the discrete and real physical nature of the lines of force radiating from an electric charge seems to me a novelty; although, as said before, a fibrous vortex structure for the ether had already been suggested and shown to be competent to transmit transverse vibrations. This essential requirement for any ether, the transmission of transverse vibration, necessarily involves some "structure" in the ether, as Lord Kelvin and others have all along perceived. Lord Kelvin favoured at one time a laminar structure, FitzGerald a fibrous structure, and Hicks had his own conception of a vortex sponge. But the difficulty in most cases was to show that these arrangements were stable and could persist without mutual destruction or hopeless wire-drawing. It is not clear whether this difficulty has or has not yet been attacked by J. J. Thomson in connection with the pictorial representation which he now brings forward.

He shows clearly, somewhat on the same lines as Mr. Heaviside, how sudden jerks or accelerations given to the lines must result in radiation, and he makes many interesting thumb-nail calculations in connection with their behaviour, among other things showing that the mass of bound or associated ether in an electrostatic line is such that if moving with the speed of light it would exactly equal the electrostatic energy of the field per unit volume; though how an electric field is to be thus thought of in any *static* manner is not clear to me. Also he is able to regard the re-distribution of the lines of a charge in rapid motion (first calculated by Mr. Heaviside in the *Phil. Mag.*, April, 1889) as not only analogous to, but as really corresponding to, the tendency of a moving cylinder to set itself broadways to the direction of motion. Furthermore, the lines of force behave very exactly as stretched elastic threads; for though their section is not uniform, their tension, *i.e.* their total stretching force, varies everywhere with their mass per unit length, so that the rate of propagation of waves along them is constant.

Altogether a fascinating and most readable book for students of physics and chemistry.

OLIVER LODGE.

SIR A. GEIKIE'S RECOLLECTIONS.

Scottish Reminiscences. By Sir Archibald Geikie. Pp. xii+447. (Glasgow: Maclehose and Sons, 1904.) Price 6*s.* net.

SCIENTIFIC readers will perhaps turn with most interest to the chapter in this charming book in which Sir Archibald, the last Scotchman for the time being who has directed the work of the Geological Survey of Great Britain, tells the story of the Scottish School of Geology. It is interesting to read along with it the pathetic lament of Principal Forbes, in Edinburgh, in 1862.

> "It is a fact which admits of no doubt that the Scottish Geological School which once made Edinburgh famous, especially when the Vulcanist and Neptunian war raged simultaneously in the hall of this society"—the Royal Society of Edinburgh—"and in the class rooms of the University, may almost be said to have been transported bodily to Burlington House. Roderick Murchison, Charles Lyell, Leonard Horner, are Scottish names, and the bearers of them are Scottish in everything save residence—our younger men are drafted off as soon as their acquirements become known. Of all the changes which have befallen Scottish science during the last half century, that which I most deeply deplore, and at the same time wonder at, is the progressive decay of our once illustrious Geological School. Centralisation may account for it in part but not entirely."

But the nation, which did not greatly mourn when it sent its sixth King James to the sister country, did not, I think, suffer any more acutely when it saw its eminent sons, Sir Roderick Murchison, Sir Andrew Ramsay, and Sir Archibald Geikie, filling in uninterrupted succession the position of Director General of the Geological Survey of Great Britain. England may congratulate herself that she showed no narrow provincial jealousy, but chose the best men she could find in the island, to direct its geological survey, and their work and their fame are hardly less dear to their countrymen, because their later years were spent, as perhaps their best known work may have been done in the south. They owed their whole training and equipment to the Scottish School of Geology.

But the note of lamentation was a little too high pitched even for the days when Forbes struck it. It is true that the disputes of the Vulcanists and the Neptunists were rather forgotten with the names of Hutton and of Jamieson. In Forbes's time it had come to be recognised that both schools were substantially in the right—that volcanic forces on the one hand and water and ice on the other are forces almost equally potent in fashioning the earth as men knew it then and as they know it now, and Murchison, Lyell, Ramsay, Geikie brought people to recognise that each of the great elements took its own dominating part in sculpturing our hills and valleys, and in laying down and dislocating the strata of our rocks. In Scotland itself there were plenty of geologists to whose memories Sir Archibald Geikie pays loving and grateful tribute, who had never left their native Scotland. Two Edinburgh journalists, Charles Maclaren, who founded "The Scotsman," and Hugh Miller, who was "The Witness," spent a great part of their lives in the field of geology. Robert Chambers worked as hard on geological subjects as he did on the improvement of the literature and of the lives of his countrymen, and Principal Forbes himself, Mr. Peach, and Prof. James Geikie have not allowed the indigenous Scotchman to lose his claim to a great place among contemporary geologists.

Sir Archibald Geikie shows that his hand has lost none of its cunning, in the delightful word pictures he has given us of some of these famous and only half forgotten men of the early Victorian era. Here is a charming cameo :—

"The illustrious Principal Forbes himself was widely known to the geological world for his researches on the glaciers of the Alps and of Norway, and on earth temperature. As one saw him in the street or in the class room, he looked singularly fragile, and it was not easy to realise how such a seemingly frail body could have undergone the physical exertion required for his notable Alpine ascents. His tall, spare figure might be seen striding from the University to the rooms of the Royal Society, of which for many years he was the active secretary. His clear brown eyes wore a wistful expression and his pale face and sunken cheeks showed how his well-chiselled features had been preyed on by serious illness. Round his long neck he always wore one of the large neckcloths then in vogue, and above this, when out of doors, he carried a thick muffler, from under which as one passed him, one might hear now and then the cough that told of the malady from which he was suffering. In his own house, especially when showing some of the beautifully artistic water-colour drawings which he had made in the course of his wanderings, the then white, almost transparent, hands told the same tale of suffering."

Take another cameo, equally striking, of that wonderful stonemason and editor, Hugh Miller :—

"His appearance in the streets was certainly most uneditorial. Above the middle height, strongly built with broad shoulders, a shock of sandy hair, large bushy whiskers, and dressed in rough tweeds, with a shepherd's plaid across his shoulder, he might have been taken for one of the hill farmers, who on market days come to Edinburgh from the uplands of the Lothians He had the true 'Highland man's ling,' the elastic, springy and swift step of the mountaineer, accustomed to traverse shaking bog and rough moor. As he swung down the North Bridge, wielding a stout walking stick, looking straight before him, his eyes apparently fixed on vacancy, and his lips compressed, one could hardly help turning to look after him and to wonder what manner of man he could be."

Of the innumerable excellent stories which delight the readers of Sir Archibald's reminiscences I shall quote only two, and they shall be in connection with well-known scientific names. One tells us how "the late Professor Tait, so widely known, and so affectionately remembered, used to cite one of the answers he received in a class examination. The question asked was 'Define transparency, translucency, and opacity,' and the following was the answer, 'I am sorry that I cannot give the precise definition of these terms. But I think I understand their meaning, and I will illustrate it by an example. The windows of this class room were originally transparent, they are at present translucent, but if not soon cleaned they will become opaque.'"

Many old Edinburgh students will still "affectionately remember" these occasionally translucent windows, and will know how their never-to-be-forgotten professor would welcome the answer.

The only other quotation I shall permit myself is from a letter written by Ami Boué, a delightful old geological friend of Sir Archibald Geikie's younger days, who had been educated in Edinburgh, where he was caught up in his youth—about the time of Waterloo—in the maëlstrom of the great geological duello between the Vulcanists and the Neptunists. Boué wrote an "Esquisse Geologique sur l'Ecosse." which Sir Archibald describes as "a most valuable treatise, in many respects far in advance of his time." Born in Geneva, with German and Austrian connections, and educated in Scotland, he seems to have spoken most of the tongues of Europe with equal courage and inaccuracy. His Edinburgh days, however, were in 1870 far in the background of his life, but there are few Englishmen or Scotchmen who would have ventured to describe their feelings in a tongue with which they had been familiar in early life, as Ami Boué did, during the calamitous Franco-German war.

"The dreadful war pre-occupations did take me all time for thinking at scientific matter, and now perhaps that distress will approach till nearer our abode! When you will know that I have very good and near parents in both armies, and you perceive the possibility of parents killing themselves without recognising themselves, nor having the opportunity to do so, you will understand that I have often headach when I ride the newspapers or hear from the quite useless slaughters which have been provocated only by those men at the head of the human society."

Too much language must have made his charming old geological friend a little mad, for Sir Archibald tells us that "all the letters to me, extending over a period of thirteen years," of this too cosmopolitan man of science, "were written in broken English," of which the letter above is a specimen.

The book is full of passages which recall one of the most delightful, and one of the earliest of Sir Archibald's books on the scenery of Scotland. I take a grateful farewell of the "Reminiscences" if you will allow me one more extract in illustration:—

> "The fate of the Celt in the Highlands has been far different. There he has found himself in a region of mountains too rugged and lofty for cultivation, save along their bases, and too continuous to permit easy access from one district to another. . . . Shut in among long, narrow, and deep glens, he has cultivated their strips of alluvium, but has too often found the thin stony soil to yield but a poor return for his labour. For many a long century he had to defend his flocks and herds from the wolf, the fox and the wild cat. The gloom of his valleys is deepened by the canopy of cloud which for so large a portion of the year rests upon the mountain ridges and cuts off the light and heat of the sun. Hence his harvests are often thrown into the late autumn, and in many a season his thin and scanty crops rot on the ground, leaving him face to face with starvation and an inclement winter. Under these adverse conditions he could hardly fail to become more or less subdued and grim."

In passages like this, admirable in description and rich in human sympathy, the book abounds.

W. J.

THE NEW ZEALAND FAUNA.

Index Faunae Novae Zealandiae. Edited by F. W. Hutton. Pp. viii+372. (London: Dulau and Co., 1904.) Price 10*s.* 6*d.* net.

WITH the exception of the valuable introduction, by the editor, which appeals to a somewhat wider circle, this is essentially a book of reference, and as such is all-important to the scientific worker. In drawing up the list of the fauna, Captain Hutton has had the assistance of specialists in various branches of zoology who have undertaken the groups with which they are most familiar, so that the work may be regarded as thoroughly complete and up-to-date. Only two land mammals—bats—are recognised as indigenous to the islands, the so-called Maori rat (*Mus exulans*) having apparently been introduced from Polynesia. This species, together with other wild forms introduced by human agency, are noticed in an appendix, and the reader will probably be surprised to find how large a list of foreigners has thus been added to the indigenous fauna. It should be mentioned that the text of the work is an "index" pure and simple, not even the local distribution of the various species being given.

After a brief historical survey of the acquisition of our present knowledge of the New Zealand fauna, Captain Hutton enters on a detailed discussion of the origin and relationships of that fauna, and since this is a subject to which he has for many years devoted special attention, his matured conclusions are of the highest value and importance.

The migratory portion of the fauna is very small, including only some half-dozen species of birds. The preponderating stationary portion may, according to Captain Hutton, be divided into a small aboriginal element, comprising species with no near relatives elsewhere, and larger Malay, Australian, and Antarctic elements, as well as several smaller ones. Among the aboriginal forms, that is to say, those which appear to have been inhabitants of the islands for a very long period, the author includes the short-tailed bat (Mystacops), the tuatera, and the kiwi. Taking a broad view of the fauna, it may be said that the terrestrial portion is mainly of Malay origin, but with somewhat strong Holarctic and Neogæic connections. This opinion is important in connection with the view that has been elsewhere expressed as to the Asiatic origin of the Australasian marsupials.

From the occurrence of a number of animals which it is impossible to believe could have crossed the sea, the author is of opinion that New Zealand is not entitled to be regarded as an oceanic island, but that at an epoch relatively remote it formed part of a large continent.

The land shells of the genus Endodonta, which range all through Polynesia, New Zealand, eastern Australia, New Guinea, and the Philippines, with an outlier in Ceylon, afford the best evidence in favour of a Polynesian continent, the Cingalese outlier pointing to the conclusion that this group of molluscs originally came from the north. The molluscan evidence will not, however, explain the South American connection.

The best zoological evidence of the latter connection, by way of Antarctica, is afforded by the earthworms of the family Acanthodrilidæ, which are unknown north of the equator, although their occurrence in Madagascar may point to a northern origin. The primary northern origin of the mainly fresh-water fishes of the genus Galaxias may perhaps also be indicated by the existence of the allied Cromeria in the Nile. Additional evidence of a connection with Patagonia is afforded by the occurrence in the Tertiary strata of South America and New Zealand of quite a number of shallow-water marine invertebrates, as, indeed, has been recently pointed out by Dr. von Ihering. Further, the occurrence of these forms in older strata in South America than in New Zealand points to the conclusion that the migration took place from the former to the latter area.

Lack of space alone prevents us from discussing in greater detail Captain Hutton's very interesting and suggestive views.

R. L.